

## THE DARWIN CELEBRATIONS AT CAMBRIDGE.

A GENERAL account of the proceedings of the Darwin celebrations at Cambridge on June 22-24, and a list of distinguished delegates and other representatives of science who came from the four corners of the earth to proclaim the greatness of Charles Darwin and his work, was given in last week's NATURE. As the chief speeches were delivered on the day we went to press, and on Thursday last, we were prevented from including any report of them in the article, which, however, we are now able to supplement. Short speeches were made in the Senate House on June 23, when the delegates were received by the Chancellor, Lord Rayleigh, and the addresses were presented; and also at the banquet given in the evening of that day.

Eloquent as this testimony was of the universal recognition of Darwin's influence upon scientific work and thought, the scenes in the Senate House and in the new examination hall where the great banquet was held were even more impressive. In each place there was an assembly of naturalists gathered from far and near charged with the spirit which animated Darwin, and alert to respond to any note of appreciation of the man or his work. As more than one speaker remarked, what Newton did to reduce celestial movements to law and order by his discovery of the law of gravitation, Darwin did for the more complex world of animate things. All bodies in the material universe are bound together by the bond of gravitational attraction which decides their past, present, or future paths; and in a similar way the unifying influence in the organic world is the principle of evolution established upon the foundation of natural selection.

The character and dignity of the celebration made a permanent impression upon the minds of all who were fortunate enough to take part in it, and the occasion has been made memorable for the scientific world in general by the publication of a number of works relating to it. One of these, on "Darwin and Modern Science," was noticed in detail last week, and we now take the opportunity of referring to others.

## PUBLICATIONS OF THE DARWIN CENTENARY.

Each delegate was furnished with a copy of two publications which will be of lasting value as souvenirs of this memorable occasion. Perhaps the most remarkable of the publications is the beautifully printed volume issued by the Cambridge University Press under the title of "The Foundations of the Origin of Species." This contains the brief abstract of the theory of natural selection written by Charles Darwin in June, 1842, sixteen years before the famous meeting of the Linnean Society at which the theory was first made known to the scientific world. The MS. of 1842, which was afterwards expanded by its author into the essay of 1844, consists of thirty-five pages written in pencil. It had been "hidden in a cupboard under the stairs, and only came to light in 1896 when the house at Down was vacated." It was, as the editor says, evidently written rapidly; and is in Darwin's most elliptical style, with much erasure and correction, the whole being "more like hasty memoranda of what was clear to himself than material for the convincing of others." Mr. Francis Darwin has laid the scientific public under an immense obligation by his admirable introduction and notes, and by the care he has taken that readers should be able to study the sketch exactly as it stood in its original form. Each of the delegates present at the celebration received a copy of this most valuable work, the importance of which in the history

of evolutionary theory it would hardly be possible to overestimate.

In addition to this work, a second volume, admirably printed by the University Press, was put into the hands of the guests at the commemoration. This production, which is purchasable by the public at the price of two shillings and sixpence, is entitled "Order of the Proceedings at the Darwin Celebration held at Cambridge, June 22-June 24, 1909; with a Sketch of Darwin's Life." It opens with a brief preface, which records the names of the committee—to whom many congratulations are due for the successful issue of their labours—and also narrates the steps that were taken, beginning with a meeting of the council of the Senate in December, 1907, to organise a celebration worthy of the man who has revolutionised science, and whose influence has made itself felt as a power and an inspiration in every department of intellectual activity. Following the programme of the commemoration proceedings comes a very interesting sketch of Darwin's life, which gives in brief compass the principal events of his career, and the dates of the publication of his various works. This short biography, in the preparation of which the secretaries to the committee acknowledge the assistance they have received from Mr. Francis Darwin, is rendered especially valuable by well-chosen quotations from the "Life and Letters," and from the appreciative comments of Judd, Lyell, Huxley, Schwalbe, Goebel, and Thiselton-Dyer. Good photographic views are given of Darwin's birthplace at Shrewsbury, of the exterior of his rooms at Christ's College, of his house and favourite "Sandwalk" at Down. There are also reproductions of several of the well-known portraits of Darwin and of his wife, including a picture of Charles Darwin and his sister Catherine as children. An excellent likeness of Sir Joseph Hooker, taken in 1897, and an interesting print of H.M.S. *Beagle* in the Straits of Magellan, complete the series.

The Rede lecture on "Charles Darwin as Geologist," delivered by Sir Archibald Geikie, K.C.B., on June 24, has been published also by the University Press, with notes, at the price of two shillings net. Reference was first made in the lecture to the early geological interests of Darwin and the formative influence of Lyell upon his mind. The first volume of Lyell's "Principles of Geology" was published early in 1830. Darwin took the book with him on his voyage in the *Beagle* and studied it, with a result that changed his opinions and began the life-long indebtedness to Lyell which he so sincerely felt and never ceased to express. In four distinct departments Darwin enriched the science of geology with new material during the voyage of the *Beagle*. First, he added to our knowledge of the volcanic history of the globe. Secondly, he brought forward a body of striking evidence as to the upward and downward movements of the terrestrial crust, and drew from this evidence some of the most impressive deductions to be found in the whole range of geological literature. In the third place, he made important observations on the geology of South America; and, finally, he furnished new and interesting illustrations of the potent part taken by the denuding agents of nature in effecting the decay and disintegration of the land. Sir Archibald Geikie proceeded to review Darwin's work under each of these four heads, and to express his appreciation of it. Finally, he sketched the later geological work carried out by Darwin and the geological side of "The Origin of Species."

Another noteworthy outcome of the present commemoration is the special Darwin centenary number of the *Christ's College Magazine*.

The proceedings on June 23 were opened in the Senate House by the following address from the Chancellor of the University, Lord Rayleigh.

#### THE CHANCELLOR'S ADDRESS.

In opening the proceedings to-day I must first, in the name of the University, bid welcome to the delegates and other guests who have honoured us by their presence. A glance at the list will show that we have assembled here distinguished men from all parts of the world who have willingly responded to our invitation; and, indeed, the occasion is no ordinary one. We have met to celebrate the centenary of the birth of Charles Darwin and the fiftieth anniversary of the publication of the "Origin of Species." I am old enough to remember something of the stir caused by the latter event. To many the results of Darwin's speculations were unwelcome, and it must be confessed remain so, at least in their application to the origin of man. Fifty years ago it would have been thought a strange prophesy if anyone had predicted to-day's celebration. We may perhaps take it as proven that Cambridge is not held so fast in the bonds of mediævalism as some would have us suppose. We are prepared to face whatever strict methods of investigation may teach to be the truth. I need not remind you that on many important questions raised by Darwin's labours opinions still differ, and I imagine that he would proudly recognise as disciples some of the distinguished biologists who meet here to do honour to his name. I do not attempt even the briefest survey of these labours. We shall presently hear appreciations from men of distinction well qualified to instruct us. What appeals to all is the character of the man, loved by everyone who knew him, and admired by everyone with a spark of the scientific spirit. It is a pleasure and a stimulus to think of him, working on in spite of ill-health in his study, in his garden, and in his hot-houses, and from his retirement moving the minds of thinking men in a manner almost without parallel. I esteem myself fortunate that a visit nearly forty-one years ago, which I owed to my friend, now Sir G. Darwin, allows me to picture the scene. I was struck, as were others, with his wonderful modesty. On my propounding some difficulty in connection with colour vision and the theory which attributed the colours of flowers to the preference of insects, I remember that he asked time for consideration before making a reply. His enthusiasm also impressed me much. This characteristic must have remained. Commenting on it only a short time before the death of both of them, Frank Balfour, himself a strenuous and sympathetic worker, remarked to me that he wished he could be as much interested in his own subject as Darwin was in other people's subjects.

During the last generation Cambridge has been active in biological work. We have the men and the ideas, but the difficulty has always been lack of funds. At the present time it is desired, among other things, to establish a chair of genetics, a subject closely associated with the name of Darwin and of his relative, Francis Galton, and of the greatest possible importance, whether it be regarded from the purely scientific or from the practical side. I should like to think that the interest aroused by this celebration would have a practical outcome in better provision for the further cultivation in his own university and in that of his son of the field wherein Darwin laboured.

At the conclusion of the Chancellor's address the presentation took place of the addresses by delegates from America, Austria-Hungary, Belgium, Denmark, Egypt, France, Germany, Greece, Holland, and Italy. Short speeches were then delivered by Prof. O. Hertwig and Prof. E. Metchnikoff.

Prof. Hertwig referred to the influence of Darwin's work upon German biology, particularly at Jena. It was through Haeckel, who hailed Darwinism with delight, and said that evolution was the key of man's destiny, that the theory became predominant in German science. It had been the starting point for all the researches of the younger men, and had entered into the life of the

German people. Earlier this year festivals in commemoration of Darwin's work were held in Hamburg, Munich, Frankfurt, and other towns in Germany. The celebration at Cambridge was the acme of these festivals, and would give an immense stimulus to the scientific work of the delegates privileged to be present at it. The influence of Cambridge upon Darwin was great and beneficial, and particular mention must be made of the encouragement received from Henslow. Three bright stars had appeared in the scientific firmament of the University, the last being Darwin and the two others Harvey and Newton.

Prof. Metchnikoff in his address referred to the debt which medical science owes to the theory of organic evolution founded by Darwin. Diseases undergo evolution in accordance with the Darwinian law, and the recognition of this fact led to the science of comparative pathology. It is possible definitely to show that inflammation is an act of defence on the part of the organism against morbid agents, and that this reaction is effected by certain cellular elements, together with a complicated and wonderful nervous and vascular mechanism. The same elements play an important part in resisting disease. The preponderating influence of the cellular action in the mechanism of immunity is admitted by the great majority of observers. Recently experimental medicine has been investigating the phenomena of adaptation in pathogenic microbes, by virtue of which we are able to attack the organism in spite of its defensive powers, and this is most probably effected by the selection of individual microbes endowed with special properties. This has happened with the micro-organism of recurrent fever. With regard to cancer, the theory must be rejected that it is caused by stray embryonic cells, shut off and remaining latent, on the ground of evolution, because the lower animals, which also possess embryonic cells, never suffer from malignant growths except when they are provoked by external agents. It is therefore very probable that cancer in man is equally caused by some external agent, some virus which has been diligently sought, but has not yet been found.

Addresses were then presented by delegates from Japan, Norway, Portugal, Russia, Spain, Sweden, and Switzerland, and by delegates from the British colonies and the British Isles. After the English delegates had been presented, Sir Archibald Geikie, K.C.B., president of the Royal Society, said that the society desired to mark the importance of that occasion by having a special copy of the Darwin medal struck in gold for the acceptance of the University. It will be remembered that the medal owes its existence to the committee of the International Darwin Memorial Fund, which in 1885 transferred to the Royal Society the balance of the fund, in trust, to devote the proceeds from time to time toward the promotion of biological studies and research. The first award was made to Dr. Alfred Russel Wallace in 1890. Lord Rayleigh was the secretary of the society when the medal was cast. It was, therefore, Sir Archibald Geikie continued, a very great pleasure to the Royal Society to have it in its power to hand to Lord Rayleigh, for acceptance of the University, a copy of the Darwin medal.

The following address was then delivered by Dr. Henry Fairfield Osborn, the delegate of the American Philosophical Society:—

#### Prof. Henry F. Osborn.

Crossing the Atlantic in honour of Darwin and rejoicing in the privilege of uniting in this celebration of his birth, we desire, first of all, to render our tribute to the University of Cambridge.

To no other institution in any country may we turn with such a sense of filial gratitude. In ever widening growth has been the influence of the Cambridge heritage, as pictured more than four centuries ago in the generous mind of Sir Walter Mildmay, the founder of Emmanuel. "Sir Walter," remarked Queen Elizabeth, "I hear that you have erected a Puritan foundation." "No, madam,"



he replied, "far be it from me to countenance anything contrary to your established laws; but I have set an acorn, which, when it becomes an oak, God alone knows what will be the fruit thereof." Through John Harvard, of Emmanuel, Cambridge became the mother of our colleges. Did not Emmanuel beget Harvard, and Harvard beget Yale, and Harvard and Yale beget Princeton and other descendants to the third and fourth generation? We thus salute to-day the venerable but ever youthful ancestor of many of the American universities, academies, and institutes of science, national and State museums, represented here, and in large part guided by true sons of the true daughters of the Alma Mater on the Cam. Through the survival of the best our political guidance is also passing more and more into the hands of men trained in these same daughter colleges. A son of Yale succeeds a son of Harvard as President of the United States. If your university men are leading the Empire ours are leading the nation.

Noble offspring, too, of the many pious foundations of the old University, of Trinity, of Christ's, are the great men too numerous to name, among whom there especially rise in our minds Newton, Clerk-Maxwell, Balfour, and, above all, Darwin. Newton opened to us the new heavens and Darwin the new earth. Clerk-Maxwell, with Hertz, enabled us to converse across the sea through the blue ether. The well-beloved Balfour set forth Darwinism in embryology; would that his life had been spared for the more difficult problems of our day. If in our hours of struggle with the mysteries of nature these are our leaders and companions, so in our hours of ease and relaxation do we not turn again to sons of Cambridge for spiritual refreshment, to the verse of Milton, of Byron, of Wordsworth and Tennyson, all richly imbued with the nature spirit, or to the no less masterly prose of Thackeray and Macaulay?

Far away are the giant forces of our Republic, the roar of her machinery and her world of trade, yet more apparent than real is the independence of her development. There still prevails the potent unifying influence of mind and motive, bred in quiet places like this, ever creating new generations of leaders in science, in literature, and in government, and ever renewing the strong bonds of friendship and of union.

What can we add to the chorus of appreciation of the great pupil of Christ's, which has come from American college, Press, and pulpit, since the opening of this anniversary year? Only a few words of personal impression.

To us Darwin, more perhaps than any other naturalist, seems greatest in the union of a high order of genius with rare simplicity and transparency of thought. Dwelling on this lucid quality and on the vast range of his observation, from the most minute to the grandest relations in nature, does not the image arise of a perfected optical instrument, in which all personal equation, aberration, and refraction is eliminated, and through which, as it were, we gaze with a new vision into the marvellous forms and processes of the living world? With this wondrous lens our countrymen Cope and Marsh penetrated far deeper into fossil life than their predecessor Joseph Leidy—thus the arid deserts of the Rocky Mountains gave up their petrified dead as proofs of Darwinism. Through its new powers Hyatt, Morse, Packard, and Brooks saw far more than their master Louis Agassiz, and drew fresh proofs of the law of descent from the historic waters of New England. From the very end of the new world, where the youthful Darwin received his first impressions of the mutability of the forms of life, came a clearer vision of the ancient life of Patagonia.

The new vision opened upon a period of great men; and this again suggests a reminiscence. Thirty years ago two of the present delegates arrived in Cambridge as students. They heard Clerk-Maxwell developing his theories before the Cambridge Philosophical Society. Michael Foster was in his prime and lecturing in his inimitable manner. Francis Maitland Balfour had just completed his "Elasmobranch Fishes," and was working five hours a day on his "Comparative Embryology"; his lectures were brilliant and inspiring; his relations with students altogether ideal; in his rooms, among many

others, one met Lankester and Moseley, and enjoyed a rare flow of conversation on all subjects except biology. Either as students or as young instructors were Sedgwick, Forbes, Shipley, Weldon, Haddon, Harmer, and others. In this Senate House Robert Browning, Spottiswoode, president of the Royal Society, and Huxley received their honorary degrees. Throughout the winter Huxley was delivering his remarkable lectures, "Darwinism in Comparative Anatomy," suggestive and with occasional flashes of humour, still strong and full of fire, but beginning to show the effect of years of overwork, of public service, and research. About once a week he came among his students. One day an unusual stir or thrill passed along the tables as with him entered Darwin, his first and only visit to a modern biological laboratory. Darwin paused for a few moments' conversation, and one received the strong impression of a ruddy face, benevolent blue eyes, very deep-set beneath the massive overhanging brow—a wonderful effect of kindliness and of the far-off world survey of a great naturalist.

What of Darwin's influence in the future? While it is doubtful if human speculation about life can ever again be so tangential or so astray on ultimate causes as in the pre-Darwinian past of fifty years ago, it is probable, in fact it is daily becoming more evident, that the destiny of speculation is less the tangent than the maze—the maze of several lesser principles, with as many prophets calling to us to seek this turning or that. There are those who, in loyal advocacy of his system, feel that we shall not get much nearer life than Darwin did; but this is to abandon his progressive leadership, for if ever a master defined the unknown and pointed the way of investigation, certainly it was Darwin. In the wonderful round of addresses in his honour of this centennial year and in the renewed critical study of his life and writings, the recognition that Darwin opened the way has come to many with the force of a fresh discovery. It is true that he left a system, and that he loved it as his own, but his forceful, self-unsparing, and suggestive criticisms show that if he were living in these days of Waagen, of Weismann, of Mendel, and of de Vries, he would be in the front line of inquiry, armed with inventive genius, with matchless assemblage of fact, with experiment and verification, and not least with incomparable candour and good-will. This bequest of a noble method is hardly less precious than the immortal content of the "Origin of Species" itself.

In conclusion, we delegates, naturalists, and friends, desire to present to Christ's College, as a memorial of our visit, a portrait of Charles Darwin in bronze, the work of our countryman William Couper, a portrait which we trust will convey to this and future generations of Cambridge students some impression of the rugged simplicity, as well as of the intellectual grandeur, of the man we revere and honour.

The speech next delivered by Sir Ray Lankester was an eloquent appreciation of Darwin's work and an unequivocal vindication of the theory of the origin of species by the preservation of minute variations favourable to existence under prevailing natural conditions.

SIR RA LANKES K.C.B., F.R.S.

I feel it a great honour to be called upon to speak here to-day, and to stand, on behalf of the naturalists of the British Empire by the side of the distinguished men whose orations you have just heard.

I think that the one thing about Charles Darwin which the large majority of British naturalists would wish to be to-day proclaimed, in the first place—with no doubtful or qualifying phrase—is that, in their judgment, after these fifty years of examination and testing, his "theory of the origin of species by means of natural selection or the preservation of favoured races in the struggle for life" remains whole and sound and convincing, in spite of every attempt to upset it.

I am not stating more than the simple truth when I say that, in the judgment of those who are best acquainted with living things in their actual living surroundings, "natural selection" retains the position which Mr. Darwin

claimed for it of being the main means of the modification of organic forms.

Our admiration for the vast series of beautiful observations and interesting inquiries carried out by Darwin during his long life must not lead us to forget that they were devised by him in order to test the truth of his theory and to meet objections to it, and that they were triumphantly successful. They, together with the work of Alfred Russel Wallace and many of their followers, have more and more firmly established Darwin's theory. On the other hand, no attempt to amend that theory in any essential particular has been successful.

The nature of organic variation and of the character of the variations upon which natural selection can and does act was not, as we are sometimes asked to believe, neglected or misapprehended by Darwin. The notion that these variations are large and sudden was considered by him, and for reasons set forth by him at considerable length rejected. That notion has in recent years been resuscitated, but its truth has not been rendered probable by evidence either of such an accurate character or of such pertinence as would justify the rejection of Darwin's fundamental conception of the importance of minute and ubiquitous variations.

Further, in regard to the important facts of heredity connected with the cross-breeding of cultivated varieties, especially in regard to the blending or non-blending of their characters in their offspring and as to prepotency, it seems to me important that we should now and here call to mind the full and careful consideration given to this subject by Darwin. We cannot doubt that he would have been deeply interested in the numerical and statistical results associated with the name of Mendel. Those results tend to throw light on the mechanisms concerned in hereditary transmission, but it cannot be shown that they are opposed in any way to the truth of Darwin's great theoretical structure—his doctrine of the origin of species.

It has often been urged against Darwin that he did not explain the origin of variation, and especially that he has not shown how variations of sufficient moment to be selected for preservation in the struggle for existence have in the first place originated. The brief reply to the first objection is that variation is a common attribute of many natural substances of which living matter is only one. In regard to the second point, I desire to remind this assembly that Darwin described with special emphasis instances of what he calls "correlated variability." In my opinion he has thus furnished the key to the explanation of what are called useless specific characters and of rudimentary organs. That key consists in the fact that a general physiological property or character of utility is often selected and perpetuated, which carries with it distinct, even remote, correlated growths and peculiarities obvious to our eyes, yet having no functional value. At a later stage in the history of such a form these correlated growths may acquire value and become the subject of selection.

It is thus, as it seems to me, and as, I believe, to the great body of my brethren naturalists, that Darwin's theory stands after fifty years of trial and application.

The greatness of Charles Darwin's work is, and will be for ever, one of the glories of the University of Cambridge. It is fitting on the present occasion that one who appears on behalf of English men of science should call to mind the nature of his connection with this great University and the peculiarly English features of his life-story and of that fine character which endears his memory to all of us as much as his genius excites our admiration and reverence. Darwin was not, like so many a distinguished son of Cambridge, a scholar or a fellow of his college, nor a professor of the University. His connection with the University and the influence which it had upon his life belong to a tradition and a system which have survived longer in our old English universities than in those of other lands. Darwin entered the University, not seeking a special course of study with the view of professional training, nor aiming at success in competitive examinations for honours and employment. He came to Cambridge intending to become a clergyman, but blessed with sufficient means and leisure to enable him to pursue his own devices, to collect beetles, to explore the fen-

country, and to cultivate his love of nature. It was thus that he became acquainted with that rare spirit Henslow, the Cambridge professor of botany, and it is through Henslow and the influence of his splendid abilities and high personal character upon Darwin that Cambridge acquired the right to claim the author of the "Origin of Species" as a product of her beneficence and activity as a seat of learning.

As an Oxford man and a member of Exeter College, I may remind this assembly that in precisely the same way Darwin's dearest friend and elder brother in science, Charles Lyell, had a few years earlier entered at Exeter College, and by happy chance fallen under the influence of the enthusiastic Buckland, the University reader in geology and a Canon of Christ Church. The wise freedom of study permitted and provided for in those long-passed days by Oxford and Cambridge is what has given the right to claim the discovery, if not the making, of Lyell to the one and of Darwin to the other.

Darwin's love of living nature and of the country life are especially English characteristics; so, too, I venture to think, are the unflinching determination and simple courage—I may even say the audacity—with which he acquired, after he had left the University, the wide range of detailed knowledge in various branches of science which he found necessary in order to deal with the problem of the origin of the species of plants and animals, the investigation of which became his passion.

The unselfish generosity and delicacy of feeling which marked Darwin's relations with a younger naturalist, Alfred Russel Wallace, are known to all. I cannot let this occasion pass without citing those words of his which tell us most clearly what manner of man he was and add to his splendid achievements as an intellectual force—a light and a beauty of which every Englishman must be proud. When in old age he surveyed his life's work he wrote:—"I believe that I have acted rightly in steadily following and devoting my life to science."

To have desired to act "rightly" and to be able to think of success in life as measured by the fulfilment of that desire is the indication and warrant of true greatness of character. We Englishmen have ever loved to recognise this noble kind of devotion in our national heroes.

In connection with the celebration, several learned bodies conferred honours upon the Chancellor, and upon Mr. Francis Darwin, F.R.S., and Sir George Darwin, K.C.B., F.R.S. Among these marks of recognition were the following:—Lord Rayleigh (Chancellor), corresponding member of the Senkenbergische Naturforschende Gesellschaft, Frankfurt-am-Main, and honorary member of the University of Moscow; Mr. Francis Darwin, member of the American Philosophical Society, foreign member of the Société Hollandaise des Sciences, corresponding member of the Senkenbergische Naturforschende Gesellschaft, Frankfurt-am-Main, honorary member of the Soc. Cæs. Naturæ Curiosorum, Moscow, honorary member of the University of Moscow, and Fellow of the Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher, Halle; Sir George Darwin, corresponding member of the Senkenbergische Naturforschende Gesellschaft, honorary member of the Soc. Cæs. Naturæ Curiosorum, Moscow, honorary member of the University of Moscow, and Fellow of the Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie der Naturforscher, Halle.

#### SPEECHES AT THE BANQUET.

At the banquet on June 23 Mr. Balfour and Prof. Svante Arrhenius proposed the toast which was drunk in silence to the memory of Darwin. In the course of his remarks Mr. Balfour said:—

Charles Darwin's performances have now become part of the common intellectual inheritance of every man of education wherever he lives or whatever his occupation or



trade in life. To him we trace in the main the view which has affected, not merely our ideas of the development of living organisms, but our ideas upon politics, upon sociology, ideas which cover the whole domain of human terrestrial activity. He is the fount and origin, and he will stand for all time as the man who has made this great, and, as I think, beneficent revolution in the mode in which educated men can see the history, not merely of their own institutions, not merely of their own race, but of everything which has that unexplained attribute of life, everything that lives on the surface of the globe or within the depths of the ocean. He is the Newton of this great department of human research, and to him we look, as we looked to Newton, to measure out heavens or to weigh suns and their attendant planets. After all, the branch of research which he initiated is surely the most difficult of all. I talk of measuring heavens and weighing suns, but surely these are tasks incomparably easy compared with the problem that attracts the physiologist and the morphologist in dealing with the living cell, be it plant, or animal, or man. That problem of life is one which it is impossible for us to evade, which it may be impossible for us ultimately to solve, but in dealing with which in its larger manifestations Charles Darwin made greater strides than any man in the history of the world has made before or any man has made since.

Prof. Arrhenius then spoke as follows:—

Evolutional ideas are as old as human civilisation. We find traces of them in old Egyptian legends of the growth of mankind, in Hindu myths, as well as in the cosmogony of Herod and in Ovid's *Metamorphoses*. During the lapse of centuries they were developed by philosophers and astronomers, *i.e.* by the men of the oldest sciences; and in the eighteenth century, when most modern sciences took a distinct shape, those ideas formed important parts of the scientific work of Kant, and still more in the admirable theoretical speculations of Lamarck. But still the finalist school, founded on primitive and mediæval considerations, was in the highest degree preponderant; and the leading biologist at the end of that century, Cuvier, had no conception of evolutionism. Even in Kant's works we find the finalistic ideas prevailing.

To accomplish the now prevailing evolutionary ideas a great work was necessary, in order that these should be developed into a system embracing all the biological sciences with the strictest logic and severest criticism. The attempts made at the beginning of the nineteenth century by many scientific men, amongst whom the name of Charles Darwin's grandfather, Erasmus Darwin, may be recalled, were far from sufficient. The epoch-making work was delivered by Charles Darwin, who, with an unrivalled patience and diligence, as well as a rare impartiality, during nearly thirty years, collected and sifted the enormous material upon which is based his masterly work "*The Origin of Species*."

It must be said that the time was ripe for the triumph of the conception of evolution, as is clearly indicated by the simultaneous work of Wallace on biology and by the publication of Herbert Spencer's philosophical investigations. Charles Darwin was also immediately followed by enthusiastic and prominent adherers, such as Huxley and Haeckel, who propagated and worked out the new doctrines.

This rapid success also caused a strong reaction from the side of the representatives of the old finalistic ideas, grown strong through centuries. The battle fought between the two parties carried the new ideas into common life, far from the men of science and the philosophers' study. During the last decade of his life Darwin had the good fortune to see his ideas brought to definite victory and generally accepted, not only in the vast domain of biology, which has been spoken of so eloquently this morning, but even by scientific men in general, and by the enlightened public opinion.

Charles Darwin had a clear perception of the far-reaching importance of his ideas. He applied them in elaborate investigations concerning the development of the intellectual and reflective faculties, to the formation of primitive social ideas amongst animals and men, to the

genesis of the most elementary moral and religious conceptions, as well as to the fundamental problems of anthropology.

The more these various questions have been discussed the more the doctrine of evolution has grown in strength, and the greater has been the extent to which science has been brought under its beneficent influence. Nowadays there is hardly a science which has not been affected and in many cases thoroughly permeated by it. The sociological and statistical sciences now rest on an evolutionary basis; history, and especially the history of culture, has found through it new lines of development; the linguist tries to find the natural laws of development of languages; the lawyer sees the legislative work of past generations and foresees their future modifications from the standpoint of evolution; the criminalist seeks the sources of crime in the influence of heredity and environment; and even the theologian, who for so long a time rejected the new ideas, finds now in them essential points of high ethical charm which he seeks to reconcile with true religion. At the same time, the investigators in exact sciences, where the doctrine of evolution had been adopted earlier than in biological sciences, were inspired to new and successful efforts to use it, as is, for example, obvious from the researches of Sir George Darwin, who, as well as the other members of the family, is a brilliant example of the heredity of intellectual properties.

Science is international; and this momentous movement has been felt in every country in the civilised world. Therefore we, representatives of all sciences, have come from all parts of the world to join you in doing homage to the memory of the greatest of all evolutionists.

All of us are profoundly sensible that the great intellectual revolution which is due to the introduction of evolutionism is the most important event in the development of the human mind, since the mighty political movement which began with the storming of the Bastille 120 years ago. There is, however, this significant difference between that time and this, that whereas in such a period every mighty change in the social, political, and intellectual development of mankind was only effected by strife and horrors of war, to-day, thanks to the civilising progress, this change has been accomplished by reason and persuasion. "The pen has been mightier than the sword." How much may we not congratulate ourselves that we have lived in such a period? In reality, the doctrine of evolution is inconsistent with violence, and we may hope, therefore, that it will give a mighty impetus to the maintenance of peace and a good understanding between civilised nations.

In conclusion, let me say that in thus venerating Darwin's memory all men of science regard him, not only as an ideal man of science, but as a man of science whose power and influence have been enhanced by his integrity and moral worth.

In replying to the toast, Mr. W. Erasmus Darwin related some interesting incidents as to Darwin's kindly and considerate nature in his home life. The toast of "*The University of Cambridge*" was proposed by Prof. E. B. Poulton, F.R.S., who asked whether the comparative freedom enjoyed by Darwin in his college life would be possible in these days of examination pressure. The vice-chancellor, in responding to the toast, said it was hoped that Dr. Wallace would attend the celebration and receive an honorary degree at Cambridge, but his health would not permit him to accept the invitation. The suggestion had been made (we understand it came from Prof. Meldola) that a message should be sent to Dr. Wallace; and the vice-chancellor announced that the following telegram had been sent:—"The naturalists, assembled at Cambridge for the Darwin celebration, cannot forget your share in the great work which they are commemorating, and regret your inability to be present."

On Thursday, June 24, the concluding day of the celebration, honorary degrees were conferred upon twenty-one of the delegates, and Sir Archibald Geikie delivered the Rede lecture already mentioned. The

Public Orator, Dr. Sandys, spoke as follows in presenting the several distinguished recipients of the degree of Doctor of Science *honoris causa* :—

PRINCE ROLAND BONAPARTE.—Agmen honorum nostrorum ducit hodie imperatoris magni fratris natu minoris nepos, cuius avunculi insignes scientiarum e provinciis inter se diversis palmas plurimas tulerunt. Ipse, Francogallorum in Republica maxima, et Instituti celeberrimi socius et Societatis Geographicae praeses iure optimo est electus. Olim geologiae, botanicae, zoologiae, anthropologiae studiis non sine gloria deditus, non modo gentis suae incunabula, insulam Corsicam, sed etiam orientem versus solem insulas remotiores victor felix exploravit. Idem orbis veteris e scientiarum castris trans aequor Atlanticum pacis satellites est profectus, velut alter Caesar

"victrices aquilas alium laturus in orbem."<sup>1</sup>

EDOUARD VAN BENEDEN, PROFESSOR OF ZOOLOGY AT LIÈGE.—Ductori nostro proximus progreditur Belgarum e gente vicina, Leodiensium ex Universitate insigni, professor praeclarus, Biologiae Archivorum fundator, cytologiae hodiernae conditor, qui, in opere singulari de *Ascaride megalcephala* conscripto, utriusque sexus cellularum nucleos etiam in morphologia idem valere diligenter demonstravit. Idem de vespertilionum, rodentium, crustaceorum, tunicatorum embryologia, deque *Dicymidorum* formis egregie disputavit. Atqui haec omnia nonnullis vestrum quam nobis notiora sunt; illud autem nobis non ignotum, zoologiae professorem tam illustrem Francisci Balfourii nostri amicum olim fidelem fuisse.

OTTO BÜTSCHLI, PROFESSOR OF ZOOLOGY AT HEIDELBERG.—Zoologiae professorem Heidelbergensem ovi cellulae in actu investigando plurimis praecursorem praeclarum exstitisse constat. Idem *Infusoriorum* de vita tota, cellularum binarum praesertim de coniugatione, opus egregium conscripsit; in aliorum et sui ipsius circa *Protozoa* laboribus recensendis, ceteros superavit; etiam bacteriorum ipsam structuram explicavit; porro, in *Protozois* et *Protophytis* illis quae nomine uno *Protista* appellantur, amyllum quomodo conformatum, quomodo distributum sit, aperte demonstravit; olim denique, non sine labore multo et minuto, *protoplasma* non iam reticulatam sed alveolarem quandam formam spumeam habere comprobavit. Nonnullorum fama cito peritura, velut spuma in fluctibus summis evanescit; viri huius in rerum natura penitus exploranda virtutem, "merses profundo; pulchrior evenit."<sup>2</sup>

ROBERT CHODAT, PROFESSOR OF BOTANY AT GENEVA.—Genevensi in Universitate, abhinc annos plus quam centum, plantarum physiologiae chemicae scientiam condidit vir illustris, Horatius Benedictus de Saussure. In eadem doctrinae sede viri tanti vestigiis summa cum laude insisit botanicae professor insignis, quem hodie salutamus. Scientiae illius de principiis praeclare disputavit; experimentis plurimis adhibitis, plantarum cotidie crescentium leges explicavit; fermentorum denique in plantis naturam ipsam patefecit. Idem, florum in scientia universa sollertissimus, non modo herbario celeberrimo inter populares suos praefuit, sed etiam algas virides minutissimas illas, quae patriae pulcherrimae lacus immensos incolunt, arte eximia depinxit, libro egregio descripsit.

FRANCIS DARWIN, HONORARY FELLOW OF CHRIST'S COLLEGE.—Patris illustris e filiis insignibus adest unus, qui patris cum operibus consociatus ultimis, viri tanti vitam et litteras diei in lucem non sine laude protulit. Botanicae provincia physiologica et libris et experimentis suis inter nosmet ipsos praeclare propagata, patris a Collegio propterea honoris causa socius merito est nominatus. Nuper, in libro egregio patris sui in honorem a plurimis conscripto, ipse et patris et sua et aliorum de motibus plantarum inventa luculenter perlustravit. Idem in anno praeterito Societatis Britannicae scientiarum finibus proferendis disputationes oratione egregia auspicatus, plantarum in motibus explicandis, plantis ipsis annorum volventium in serie memoriam quandam tribuebat. Hanc potissimum ob causam, non modo patris, sed etiam proavi, Florae poëtae eximii, ingenium praeclarum utriusque in progenie revixisse crediderim.

KARL F. VON GOEBEL, PROFESSOR OF BOTANY IN MUNICH.—Bavaria ad nos misit Florae ministrum insignem

Monacensem, qui, post peregrinationes longinquas in India, in Venezuela, in Australia toleratas, de studiis suis pulcherrimis cum oratore Romano potest dicere :—"haec studia delectant domi; haec studia nobiscum peregrinantur."<sup>3</sup> Florum de biologia universo, florum de formis inter se diversis et originis et loci e natura varia exortis, florum de partibus minutissimis accuratissime describendis, quam praeclare meritis est! Darwini nostri de florum scientia inventa insignia quam penitus perscrutatus est; etiam ipse rerum naturae provinciae illius pulcherrimae in penetralia intima quam feliciter penetravit!

LUDWIG VON GRAFF, PROFESSOR OF ZOOLOGY AT GRAZ.—Salutamus deinceps virum genere insigni natum, Academiae et Berolinensis et Vindobonensis socium, in Universitate Graecina zoologiae professorem iucundissimum, qui liliorum marinorum parasi cuiusdam anatomiam impeditam primus explicavit; quique non modo opera tria egregia de *Turbellariis* conscripsit, sed etiam de animalium parasi in universum praeclare disputavit. Hodie vero magis iucundum, immo magis opportunum est, orationem illam eximiam recordari, quam abhinc annos tredecim zoologiae post Darwinum nostrum fortunis describendis dedicavit. Quod autem ad annum proximum attinet, auguramur virum tanta benignitate, tanta comitate praeditum, gentium omnium zoologis in Universitatem suam convocatis praesidem fore sine dubio acceptissimum.

RICHARD HERTWIG, PROFESSOR OF ZOOLOGY IN MUNICH.—Zoologiae professorem insignem Monacensem deinceps contemplatus, protinus videor mihi ante oculos ponere "par nobile fratrum."<sup>4</sup> Cum fratre suo illustri Berolinensi consociatus, quem hodie praesentem honoris causa salutamus, *Medusarum* et *Polyporum* de nervis sensibusque, anemonum marinae de embryologia et anatomia, cellularum in universum de morphologia et physiologia, animantium denique de corporis inferioris intervallo quodam interiore quod *κοίλον* nominatur, plurima praeclare conscripsit. Ipse, non modo zoologiae studiosis encheiridion doctrinae variae plenum donavit, sed etiam peritorum in usum de *Radiolariorum* morphologia, de *Actiniariis* a nostratibus e profundo mari reportatis, de *Protozoorum* denique structura vitaeque tota, erudite disputavit. Per orbem terrarum totum nota est praeceptoris tanti schola zoologica Monacensis, ex qua, "tamquam ex equo Troiano,"<sup>5</sup> tot milites optimi exierunt.

HARALD HÖFFDING, PROFESSOR OF PHILOSOPHY AT COPENHAGEN.—Philosophiae professorem insignem Hauniensem Darwini in honorem legatum esse missum nemo mirabitur, qui ex opere eius novissimo didicit inter philosophiam et rerum naturae scientiam prorsus distinguere perquam esse arduum. Philosophiae in historia sua in tot linguas reddita, quid potissimum spectet, fortasse requiritis. Respondeo :—philosophi cuiusque personam. Etiam in psychologiae studio, quid praesertim praesumit? Personam. Deinde, religionis in philosophia, et officiorum in finibus proponendis, quid demum magis indies ante oculos nostros positum esse existimat? Ordinis magis continui adpetitio, partim in unaquaque persona, partim inter se diversis in personis. Quid denique professorem ipsum, non modo Reginae nostrae, populari suae, sed etiam amicis suis omnibus, tam amabilem reddit? Ipsius persona. Videtis virum sagacem, qui caritate summa adversus omnes imbutus, "omnia sperat";<sup>6</sup> quique ingenio bene temperato, animo bene librato praeditus, monitum illud Horatianum constanter conservat :—"aequam memento rebus in arduis servare mentem."<sup>7</sup>

JACQUES LOEB, PROFESSOR OF PHYSIOLOGY IN THE UNIVERSITY OF CALIFORNIA.—Oceani Pacifici a litore legatus ad nos advectus est Californiae in Universitate physiologiae professor, veritatis indagator pertinax, qui, experimentis exquisitis adhibitis, rerum earum, quarum in medio animalia versantur, effectus inter se diversos distinguere est conatus. Non modo de caloribus sed etiam de coloribus et luminis vi, de geminorum origine, echinorum denique de ovi maturitate aut sanguine injecto aut sale infuso in maius exaucta, quam subtiliter disputavit! Etiam in alia rerum provincia, Horati in saeculo, Epicuri

<sup>1</sup> Cp. Cicero, *pro Archia*, 16.

<sup>2</sup> Horace, *Serm.* ii. 3, 243.

<sup>3</sup> Cicero, *De Oratore*, ii. 94.

<sup>4</sup> S. Pauli *Ep.* ad Cor. i. xiii. 7.

<sup>5</sup> *Carm.* ii. 3, 1.

<sup>6</sup> Lucan, v. 238.

<sup>7</sup> Horace, *Carm.* iv. 4, 65.



(nisi fallor) sectator quidam tractabat "echinos, ut melius, muria."<sup>1</sup>

EDMOND PERRIER, DIRECTOR OF THE NATURAL HISTORY MUSEUM, PARIS.—Sequitur deinceps Francogallorum Instituti celeberrimi et Academiae Medicae socius insignis, qui historiae naturalis Museum Parisiense tutelae suae creditum optime ordinavit. Olim, in philosophiae zoologicae incrementis enarrandis, populari suo, Stephano Godofredo Saint-Hilaire, inter Darwini nostri praenuntios locum praeclarum vindicavit. Ipse postea zoologiae universae describendae opus eximium consecravit. Quid dicam de animalium coloniis ab eodem accuratissime examinatis? quid de vermibus terrenis, quid de maris Mediterranei liliis dilucide descriptis? Illud unum dixerim: mari profundo penitus explorando plus quam semel peregre praeiit, interque rerum naturae interpretes optimos exstitit, qui patriae in gloriam numquam perituram

"referebant navibus altis  
occulta spolia, et plures de pace triumphos."<sup>2</sup>

GUSTAV ALBERT SCHWALBE, PROFESSOR OF ANATOMY AT STRASSBURG.—Anatomiae professor Argentoratensis, in Aegypto et in America Septentrionali orbis novi et orbis antiqui explorator, anthropologiae provinciam totam peragravit; sensuum humanorum rationem universam explicavit; hominum antiquissimorum capita et ossa hic et illic reperta accuratissime descripsit. Homo est; humani nil a se alienum putat.<sup>3</sup> Stilo perquam lucido praeditus, non modo *Hominem primigenium* sed etiam *Pithecanthropum erectum* litterarum monumentis mandavit. Atqui, si antiquas quoque litteras licet hodie recordari, non de hominis propinquo quodam paupere, non de simia quadam mentis sublimioris nescia, sed de homine ipso donis optimis divinitus donato poëtae antiqui verba illa dicta sunt:—

"os homini sublime dedit, caelumque tueri  
iussit, et erectos ad sidera tollere vultus."<sup>4</sup>

HERMANN GRAF ZU SOLMS-LAUBACH, PROFESSOR OF BOTANY AT STRASSBURG.—Salutamus etiam botanicae professorem Argentoratensem, virum genere antiquo, genere per annos prope octingentos nobili oriundum, qui arborum et plantarum reliquias antiquissimas saxorum in latebris conservatas opere in illo eximio descripsit, quod etiam in Britannia palaeophytologiae ad studium aditus faciliore plurimis patefecit. Idem, non modo Actis Botanicae edendis iam per annos viginti feliciter interfuit, sed etiam ipse de geographiae botanicae principiis, de floribus paratis, de fungis et algis, de sinus Neapolitani corallinis, de fragaria, de tritico, de tulipa, de ficu, de aliis denique hortarum nostrorum plantis plurima non sine gloria conscripsit.

"Patriam obruit olim  
gloria paucorum, et laudis tituliq; cupido  
haesuri saxis cinerum custodibus, ad quae  
discutienda valent steriles mala robora ficus";<sup>5</sup>

haec autem generis nobilis progenies, vir iucundus, lepidus, modestus, titulo nostro dignissimus, tot rebus ingenio summo penitus exploratis, omnium bonorum in laude "monumentum aere perennius" invenit.

CLEMENT TIMIRIAZEFF, PROFESSOR OF BOTANY IN MOSCOW.—Meministis fabulosum illum Collegiorum nostrorum unius alumnium, qui ad insulam *Laputa* peregrinatus, incolas eius omnes solis de salute cotidie sollicitos invenit, inque Academia celeberrima Lagadensi professorem quandam venerabilem vidit, qui solis radiis e cucumerum cellulis eliciendis annorum octo labores incassum impenderat. Consilium tam mirum non prorsus absurdum fuisse botanicae professor quidam Moscensis coram Regia Societate nostra non sine lepore indicavit. Scilicet per longos labores ipse comprobavit non modo solis radios in cucumi esse inclusos, sed etiam fructuum frondiumque omnium partem viridem solis e lumine radios illos tremulos eligere, quorum auxilio carbonium (ut aiunt) in aëre toto diffusum in materiam quandam vivam permutat. Idem spectri (quod dicitur) e parte rubra radios illos exortos esse docuit, qui frondium in vitam mutati, omnium hominum, omnium animalium corpora per tot saecula aluerunt. Ergo de spectri illius exemplo pulcherrimo, de

arcu caelesti, verba olim divinitus dicta saeculo nostro sensu novo denuo commendata sunt—"Erit arcus in nubibus, et recordabor foederis sempiterni quod pactum est inter Deum et omnem animam viventem universae carnis, quae est super terram."<sup>1</sup>

FRANTIŠEK VEJDOVSKÝ, PROFESSOR OF ZOOLOGY IN PRAGUE.—Bohemorum in Universitate Pragensi zoologiae professor praeclarus, patriae inter flumina lacusque, spongillarum vermiumque in varietate maxima, studiorum suorum argumenta plurima invenit. Idem, bacteriorum in structura investiganda, etiam nucleum secundum ipsam normam invenisse dicitur. Deinde, de nucleorum natura in universum, deque ovi fecundi reddendi ratione omni, nunc maxime inquit. Denique, ne laudationis nostrae in fine aculeum quandam desideretis, ne scorpionum quidem genus intactum reliquit.

MAX VERWORN, PROFESSOR OF PHYSIOLOGY AT GÖTTINGEN.—Goettingensis Universitas, vinculo antiquo cum Britannis coniuncta, legatum ad nos misit physiologiae professorem insignem, virum ingenio versatili et multiplici praeditum, qui non modo archaeologiae regionem antiquissimam, aevi medii artes, scientiam denique numismaticam temporis subsicivi in deliciis habuit, sed etiam ante omnia scientiae illi magnae quae vitam universam investigat vitam prope totam dedicavit. Peritis notum est (ne minora commemorem) opus illud ingens annorum quattuordecim in spatio iam quinquies in lucem editum, in quo a cellulis singulis exorsus physiologiae provinciam totam ita peragravit, ut non modo scientiae ipsius historiam, philosophiam, psychologiam ipse suo Marte tractaverit, sed etiam aliorum inventa praeclara ingenii sui lumine illustraverit.

HERMANN VON VÖCHTING, PROFESSOR OF BOTANY AT TUBINGEN.—Florae in sacerdote celeberrimo Tuebingensi Darwini nostri discipulum praeclarum agnoscimus, qui plantarum in motibus accuratissime examinandis felicissimus, docet libramento quam exquisito nutet tremulae flos violae, caput aureolum exserat narcissus; quanta sollertia herba quaeque viridis frondes suas ita explicet, ut solis lumen vitale quam plurimum accipiat. Idem, "polaritatis" secundum legem quandam, ostendit in arborum ramis amputatis quantum a parte summa pars ima discrepet; quot quaestiones subtilissimas sapientissimo cuique subiciat rusticus ille simplex, qui ex omni hominum memoria in perpetuum conservat,

"quos ipse via sibi repperit usus:  
hic plantas tenero abscondens de corpore matrum  
deposuit sulcis, hic stirpes obruit arvo."<sup>2</sup>

HUGO DE VRIES, PROFESSOR OF BOTANY AT AMSTERDAM.—Darwini nostri in memoriam decoramus hodie botanicae professorem Amstelodamensem, virum a Societate Regia numismate aureo Darwini in honorem instituto donatum. Quam pulchre ostendit, quam varium, quam mutabile sit florum genus illud pulchrum quod primula vespertina vel potius *Oenothera* nominatur! Alii, inter quos honoris causa Raium nostrum<sup>3</sup> nominamus, aiunt; "Natura non facit saltus"; hic autem speciem unamquamque, non e fluctuatione tam tarda ut oculorum aciem effugiat, sed e mutatione subita censet exoriri. Natura saltus igitur nonnumquam facit.

CHARLES DOOLITTLE WALCOTT, SECRETARY OF THE SMITHSONIAN INSTITUTE, WASHINGTON.—Trans aequor Atlanticum alter ad nos venit legatus insignis, Instituti celeberrimi Washingtonensis administrator indefessus, Americanorum in Republica maxima explorationi geologicae universae quondam praepositus. Zonae Olenelli, rupium illarum antiquissimarum, in quibus vitae formae fossiles (ut aiunt) repertae sunt, de incolis extinctis praeclare disputavit. Idem Cambriae in saxis, non modo *Brachiopoda* subtilissime examinavit, sed etiam *Trilobites* illos, quorum in oculo uno saxi in caligine aeterna clauso radorum lucidorum sex milia olim scintillabant. Rerum natura, in magnis magna, in minimis quam immensa!

EDMUND BEECHER WILSON, PROFESSOR OF ZOOLOGY IN THE COLUMBIA UNIVERSITY, NEW YORK.—Populari suo proximus adsurgit Novi Eboraci in Universitate Colum-

<sup>1</sup> Genesis, ix. 16.

<sup>2</sup> Virg. Georg. ii. 22 f.

<sup>3</sup> John Ray, *Historia Plantarum*, i. (1686) 50. "Cum enim Natura (ut dici solet) non faciat saltus, nec ab extremo ad extremum transeat, nisi per medium . . ."; cp. Linnaeus, *Philosophia Botanica* (1770), p. 27, § 77.

<sup>1</sup> Serm. ii. 8, 52 f. <sup>2</sup> Juvenal, viii. 106 f. <sup>3</sup> Terence, *Heaut.* 77.

<sup>4</sup> Ovid, *Met.* i. 85 f.

<sup>5</sup> Juvenal, x. 143 f.

biana zoologiae professor, qui saltationes illas *karyokinesis* nomine nuncupatas descripsit, quas ovorum in cellulis dividendis nucleorum fragmenta certatim exercent. In insectis autem nonnullis, docente doctore nostro novo, determinatur sexus, prout nucleorum fragmentum unum aut adest aut abest. Genus femininum tot fragmenta efficiunt; fragmenta uno tantum minora masculinum. Videtis, Academici, discrimine quam tenui genus masculinum a genere feminino separetur, ne dicam superetur.

CHARLES RENÉ ZEILLER, PROFESSOR OF PALAEOBOTANY IN PARIS.—E tot doctoribus supremus adest Francogallorum Instituti celeberrimi socius, palaeobotanicae professor praeclarus Parisiensis, qui iam per annos triginta plantas fossiles (ut aiunt) accuratissime examinavit; Africae, Americae, Indiae, Asiae Minoris flores extinctos non sine summo iudicio, non sine summo ingenio, investigavit. Viri huius auxilio, Florae antiquae e monumentis non iam unum alterumve capitulum perbreve, non iam paginae cuiusque lineae paucissimae, sed novae paginae plurimae, orbis terrarum quasi vitae perpetuae ad catenam continuam anulos novos addiderunt.

"Sic unumquicquid paulatim protrahit aetas  
in medium, ratioque in luminis erigit oras.  
namque alid ex alio clarescere et ordine debet  
omnibus, ad summum donec venerit cacumen."<sup>1</sup>

Rerum naturae seriem aeternam claudit *Homo sapiens*:  
honorum nostrorum seriem hodiernam claudit vir in Flora  
antiqua sapientissimus, Carolus Renatus Zeiller.

#### A NEW ANALYTICAL ENGINE.

THE April number of the Scientific Proceedings of the Royal Dublin Society contains an interesting and very original paper by Mr. Percy E. Ludgate on a proposed analytical machine. Of all calculating machines, the analytical machine or engine is the most comprehensive in its powers. Cash till reckoners and adding machines merely add or add and print results. Arithmometers are used for multiplying and dividing, which they really only accomplish by rapidly repeated addition or subtraction, with the exception alone, perhaps, of the arithmometer of Bollée, which, in a way, works by means of a mechanical multiplication table. Difference engines originated by Babbage produce and print tables of figures of almost any variety, but the process is one of addition of successive differences. The analytical engine proposed by Babbage was intended to have powers of calculation so extensive as to seem a long way outside the capacity of mere mechanism, but this was to be brought about by the use of operation cards supplied by the director or user, which, like the cards determining the pattern in a Jacquard loom, should direct the successive operations of the machine, much as the timing cam of an automatic lathe directs the successive movements of the different tools and feeding and chucking devices. However elaborate the mechanism of Babbage, if completed, might have been, the individual elements of operation would, so far as the writer has been able to understand it, have been actually operations of addition or subtraction only, and, with the exception of the method of multiplication created by Bollée, the writer does not recall any case in which mechanism has been used to compute numerical results except by the use of the processes of addition or subtraction, simple or cumulative. Of course, harmonic analysers and other instruments depending on geometry are not included in the category of machines which operate on numbers.

The simplicity of the logarithmic method of multiplying must have made many inventors regret the inherent incommensurability of the function to any simple base, or, if commensurability is attained for any particular number and its powers by the use of

an incommensurable base, the incommensurability of the corresponding logarithms of numbers prime to those first selected. On this account the writer has always imagined that the logarithmic method was unsuited to mechanism, or, if applied at all, could only be so applied at the expense of complication, which would more than compensate for the directness of the process of logarithmic multiplication.

Mr. Ludgate, however, in effect, uses for each of the prime numbers below ten a logarithmic system with a different incommensurable base, which as a fact never appears, and is able to take advantage of the additive principle, or, rather, it is so applied that the machine may use it. These mixed or Irish logarithms, or index numbers, as the author calls them, are very surprising at first, but, if the index numbers of zero be excepted, it is not difficult to follow the mode by which they have been selected. The index numbers of the ten digits are as follows:—

Digit	...	...	0	1	2	3	4	5	6	7	8	9
Index number.	50	0	1	7	2	23	8	33	3	14		

When two numbers are to be multiplied, the index numbers of the several digits are mechanically added to the index numbers of each of the digits of the other, and, the process of carrying the tens being carried on simultaneously, the time required is very small. For instance, the author gives as an example the multiplication of two numbers of 20 digits each, which will require 40 of these additions, which he shows will require  $9\frac{1}{2}$  time units if a time unit is one-tenth of the time of revolution of a figure wheel.

Unfortunately, while the principle on which the proposed machine is to work is described, only the barest idea of the mechanical construction is given, so that it is difficult to judge of the practicability of the intended construction. Whatever this may be, the originality of the method of mixed commensurable logarithms to incommensurable bases seems to the writer so great and the conception so bold as to be worthy of special attention.

Division has hitherto always been effected by the process of rapid but repeated subtraction, following in this respect the method practised with pencil and paper. Having discovered how to harness the logarithm to mechanism, Mr. Ludgate would, it would be expected, have managed to effect division by a logarithmic method, and possibly he could have done so, but here again he has left the beaten track, and by his ingenuity has made division a direct, and not, as hitherto, an indirect or trial-and-error process. Starting with a table of reciprocals of all numbers from 100 to 999, which in a mechanical form is intended to be stored in the machine, he imagines both numerator and denominator of the required fraction  $p/q$  to be multiplied by the reciprocal  $A$  of the first three digits of  $q$  so as to become  $Ap/Aq$ .  $Aq$  must, then, in every case begin with the digits 100, and it may be written  $1+x$ , where  $x$  is a small fraction. Then  $p/q = Ap(1-x)(1+x^2)(1+x^4)(1+x^8) \dots$  a highly convergent series of which five terms will give a result correct to twenty figures at least, and so division is intended to be effected by a process of direct multiplication.

Until more detail as to the proposed construction and drawings are available it is not possible to form any opinion as to the practicability or utility of the machine as a whole, but it is to be hoped that if the author receives, as he deserves, encouragement to proceed with his task, he will not allow himself to become swamped in the complexity which must be necessary if he aims at the wide generality of a complete analytical engine. If he will, in the first instance, produce his design for a machine of restricted

<sup>1</sup> Lucretius, v. *ad finem*.